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TREFF: Reflectometer and instrument component test beamline at MLZ

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Abstract: TREFF is a high resolution polarized neutron reflectometer and instrument component test beamline resulting in a highly modular instrument providing a flexible beam line for various applications.

1 Introduction

Serving for both purposes – high resolution polarized neutron reflectometer and instrument component test beamline, TREFF has been consequently built to provide a modular and flexible set-up.
A pyrolytic graphite (PG) monochromator (2) is reflecting the the lower part of the neutron guide NL5-S (1) with a cross section of 29 × 100 mm^2 under a fixed scattering angle of $2\Theta M = 90°$ resulting in neutron beam with two monochromatic wavelengths of of λ = 4.73 Å (002) and $\lambda/2$ = 2.37 Å (004). The second monochromator (5) is redirecting the neutron beam back, parallel to the NL5-S neutron guide direction. Both of them are inside radiation shielding housings. A neutron guide element with m=2 supermirrors on the top and bottom faces (3) is placed between the two monochromators in order to

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increase the transported intensity in the vertical direction. The second shielding includes the cooled Be-filter setup (4) and a beam monitor (6). The Be-filter effectively scatters out neutrons with wavelength less than 4.05Å, thus serving here as filter for the $\lambda/2$ = 2.37Å neutrons. Between 2nd monochromator and sample stage the primary beam collimation is realized by two remote controlled slits (8 & 10) with a distance of 1820mm. Further a Fe-Si supermirror can be moved into the beam path as polarizer (7) allowing together with the adiabatic rf resonant spin flipper (9) polarized neutron experiments.

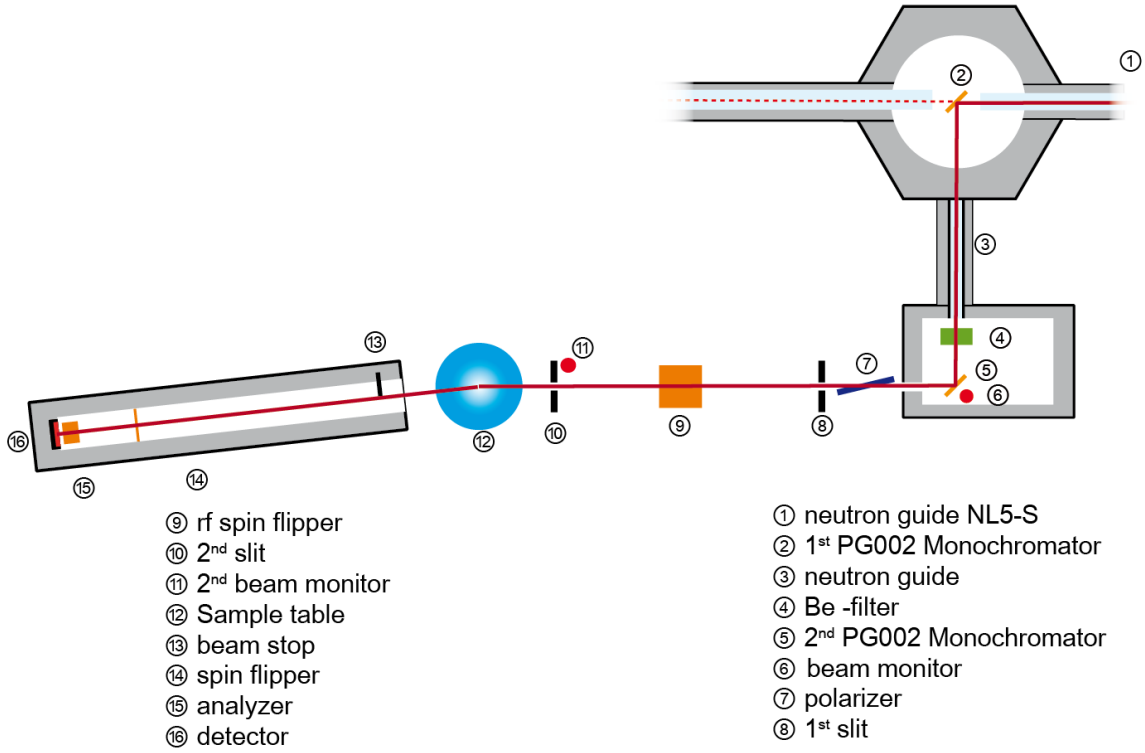

Figure 1: Schematic layout of TREFF.

The sample table (12) consists of stages for tilt ϕ (±7°) and χ (±20°) and rotation ω (±180°) with on top translation stages for x (±7 cm), y (±7 cm) and z (±7 cm). The sample may be pre-oriented by a laser. The sample table can carry loads up to 300 kg.
The default detector arm for reflectometry and diffraction is attached to a high precision bearing at the sample table. Motorized by a friction wheel scattering angles between -15°< 2Θ < 120° are accessible. It can easily be removed to give space for alternative setups, for instance a detector test bench or a Neutron Depth Profiling spectrometer. The 2D scintillation detector (16) is mounted at a distance of 1.9 m from the sample position at the end of a flight tube, which can be filled with He to reduce air scattering. Inside the tube as further components a beamstop (13), a spin flipper (14) and the polarization analyzer (15) are placed. The magnetic guide field reaches to the analyzer position.
The beamstop blocks the direct beam at small scattering angles to reduce detector background. It consists of a Li polymer with a cadmium stripe for a sharp edge and can be moved inside or outside the beam with a precision better than a detector pixel width. The polarization analyzer is a radial supermirror stack originally designed for HADAS (Rücker et al., 2000). A Mezei spin flipper consisting of two Al coils with perpendicular winding is used to flip the neutrons in front of the analyzer. The detector itself is a 2D scintillation detector with an active area of 80 mm in diameter, with a pixel size of 0.4 mm and a FWHM resolution of 1.2 mm. At the typical sample to detector distance of 1.9 m it covers an angular range of Δ2Θ = 2.4°.
TREFF is operated using the MLZ standard control software NICOS. Scan data is written to plain text

files containing the full instrument setup information and the scan data table. Further the detector images per scan point are saved as 256*256 pixel intensity information into separate files.

2 Typical Applications

The main purpose of TREFF is to serve as a development and test instrument for new instrument components and methods. Major applications are characterization and performance measurements of all kind of neutron detectors, diffraction measurements of the reflectivity and mosaicity of monochromator crystals and reflectivity measurements ensuring quality control of supermirror coatings or even Neutron Depth Profiling measurements.

3 Sample Environment

Standard holders for reflectometry samples including a vacuum suction holder are available. Further an electromagnet (0.3 T without pole shoes, maximum sample height 13 cm, 0.7 T with pole shoes, maximum sample height 5 cm) and the corresponding closed cycle cryostat ($T \geq 3.5$ K, maximum sample height 2 cm, including an electric field setup for up to 500 V), is available besides other devices from the MLZ sample environment pool.

4 Technical Data

4.1 Primary Beam

- Located at the neutron guide NL5-S
- Monochromator: PG(002) double monochromator
- Wavelength: 4.73 Å / 2.37 Å (PG 002/004)
- vertical sample, horizontal scattering plane

4.2 Distances and Angles

- 1820 mm distance S1 – S2 (collimation)
- 400 mm distance S2 – sample
- 50 mm x 40 mm (w x h) max. opening S2
- 1910 mm distance sample – detector
- -15° to 120° maximum detector angle

4.3 Polarisation Analysis

- FeSi transmission polarizer
- rf spin flipper before sample position
- Mezei type spin–flipper after sample position
- remanent FeCoV / TiN supermirror analyzer

4.4 Detector

- 2D Scintillation detector
- active area Ø 80 mm
- pixel size 0.4 mm
- FWHM resolution 1.2 mm

References

Rücker, U., Alefeld, B., Bergs, W., Kentzinger, E., & Brückel, T. (2000). The new polarized neutron reflectometer in Jülich. *Physica B: Condensed Matter*, *276-278*, 95 - 97. http://dx.doi.org/10.1016/S0921-4526(99)01257-0